

[Speaker: Kristen Ardani]

Slide 1: Good afternoon, everyone. Thank you for joining the Distributed Generation Interconnection Collaborative Monthly Informational Webinar. My name is Kristen Ardani, and I'm an analyst here at NREL and the moderator for the DGIC. So today, we are kicking off 2016 with a joint presentation from two Arizona utilities that have implemented utility owned rooftop solar programs. These programs are first of their kinds in the US. And also, I want to let everybody know about our new DGIC activities plan for the year, including a technical assistance opportunity available for utilities. There will be an application that will be accepted until January 22nd for the CA opportunity, and I provide you with the link for that application in subsequent slides.

Slide 2: So before we dive into the technical content, a few logistics. Everyone is in listen only mode, and you can ask a question by using the Q&A panel on the right hand side of your screen. We will take a few minutes between each presentation for Q&A, and then a more in-depth group discussion Q&A at the very end. To ask a question during the webinar, please click the Q&A box in the toolbar and type in any question you may have. And the webinar is being recorded and it will be posted on the DGIC webpage shown here at the bottom of the slide.

Slide 3: First I'm going to briefly walk through an overview of the DGIC group, and then we'll have about 55 minutes for our speakers to present, and this leaves us at the time for a few questions in between speakers an approximate 30 minutes for Q&A at the end.

Slide 4: So the distributed generation interconnection collaborative is supported by the U.S. DOE SunShot Initiative. And it is a stakeholder group that was formed following a workshop in October 2013, and the focus of the group is to identify knowledge gaps, technical gaps in areas where the PV interconnection process can be improved, especially as we're seeing higher penetrations of distributed PV requests being added to the grid.

And so one thing that we're very, very excited here about at NREL for the DGIC this year is that there's a new technical assistance opportunity for utilities that's being made available through our solar technical assistance team. And in the past, the solar technical assistance team has responded to requests for assistance from states, municipalities, and others, and now we're opening and broadening its opportunity to electric utilities as well. So for example, TA can be requested on matters that require any kind of solar expertise related to topics like programmatic

conceptualization or existing program design or long-term utility strategic planning.

But really, the field is pretty open at this point. So if you're interested and you're an eligible electric utility, you can fill out the request form. If you would like to have more information, you can see the website, or e-mail stat@NREL.gov. Again, the deadline for applications is on January 22, and I'd encourage all eligible parties to apply.

Slide 5: So in terms of the DGIC framework, previously we had two areas of focus. Practices and protocols and pure exchange, and practices and protocols is really focused on documenting and understanding current practices and approaches and identifying replicable innovation and consistency for the PV interconnection process, and then our second area is on pure exchange.

Slide 6: So we have our monthly and quarterly webinars, and we have a technical review committee for NREL research, and basically a stakeholder consortium to discuss interconnection challenges, and new this year, like I mentioned, we have our third area of technical assistance. So please do contact stat@NREL.gov for more information, and also here is the link to both of our websites. The first link here is to the DGIC webpage. On this webpage, you will find all of our past presentations, you will find our blog, and you will find links to all the DGIC research that has been done in the past year on interconnection.

And then on the second link there, you can see where to apply for the NREL technical assistance for utilities.

Slide 7: So with that, I'd like to go ahead and introduce our speaker. Our first speaker is Justin Orkney, and Justin joined Tucson Electric Power as the technical specialist in 2013, and is currently the program manager of distributed generation. In this position, he oversees residential and small commercial solar installations, currently being interconnected within TEP service territory as well as other more innovative solar programs, such as TEP's new residential solar offering.

Justin received a degree in mechanical engineering from the University of Arizona in 2005. He also has been a NAV Step certified PV installer for over five years and recently sat on the NAV Step committee to develop a new PV system inspector credential available later this year. And then our second speaker is Marc Romito, who is the manager of the Arizona Public Service

Renewable Energy Program. His responsibilities include program design and analysis, representing renewable energy programs and initiatives at the Arizona Corporation Commission, and serving as a renewable energy liaison between APS and the media or other public stakeholders.

Currently, his key areas of focus include efforts to integrate renewable energy onto utility grid and developing creative ways to diversify the APS solar portfolio that best serves customers. Marc has a BS in geology from the University of Kansas, a master of business of administration from the University of Kansas, and a master's of science and management from the University of Arizona. So with that, I'd like to turn it over to Justin to kick off our presentation.

[Speaker: Justin Orkney]

Slide 8: Thank you, Kristen. I'd like to start by thanking NREL for the opportunity to present today, and happy to share the time with Marc from APS. He's been doing a lot of great things with solar in Arizona for many years now.

Slide 9: I'll be speaking more to the program aspect of our utility owned residential solar program, and what I mean by that is I'll be taking a look at what it was like to implement the systems and the program, and then Marc will be speaking later to more technical nature that both our programs share.

And we'll start out with giving a little bit of context on where we see ourselves in terms of solar here in Tucson, and specifically how that led to the development of the residential solar program, the value that we see as a company, and we feel we're giving to our customers, the mechanics that are involved, including specifically the tariff, and then leading up to this presentation, I was having discussions with NREL regarding a report they're going to be putting out here soon dealing with utilities' involvement in solar deployment and opportunities to affect soft costs, and some particular aspects of our program sort of bubble to the surface.

And I decided to highlight those in this presentation are those in marketing, customer relationship are the materials and the installation. And then as Kristen mentioned, there'll be Q&A at the end.

Slide 10: So getting to the title of my presentation, the real line-side tap, as I mentioned, Marc will be discussing the more technical aspects that our programs share, but this will be as technical as I get. What

we're talking about here is utility owned residential solar interconnected on the utility side of the meter. And as you perhaps noticed in my title slide, that was our first installation. And for the most part, the systems that we're installing are identical to grid tied systems, residential grid tied systems in terms of modules, inverters, and whatever else in the system. The one technical nuance that is really important for both the program aspect and the technical aspect is that our systems are literally interconnected on the utility side of the meter.

And that gives us an opportunity to really do things a bit differently, and we'll talk about that more moving on.

Slide 11:

So next slide. Getting into the context of where we see ourselves today, Tucson Electric Power serves just under 400,000 residential customers, and we are a vertically integrated public service corporation that is regulated by the Arizona Corporation Commission. We generally refer to that as the ACC, and in the state of Arizona, we have a reasonable portfolio standard, like many other states. Ours is 15 percent by 2025. One relatively unique aspect of our renewable portfolio standard is what we refer to as the DG carve out. That states that 30 percent of our renewable generation needs to be met from distributed sources, DG, and it's equally split between residential and non-residential.

So for TEP, this means that in 2025, that equates to about 425 million kilowatt hours annually of what up until this point was considered behind the mirror generation. And in TEP service territory, we are approaching 500 megawatts in terms of our overall renewable portfolio. Four hundred and twenty of that is solar, and of that solar, we are approaching 150 megawatts of DG. This year, a few weeks ago, we close out the 2015 year with 4,000 applications, again, comparing that to our 400,000 residential customers.

So we have 4,000 applications that was about 30 megawatts of residential solar just in 2015 alone, and that did not include our program. And so this is the context that we see ourselves in, we know our customers are interested in solar, and it's happening, and it's happening on the rooftops.

Slide 12:

So our solution or our opportunity to engage with our customer in the renewable and residential solar space is our TEP owned residential solar program. We really do see it as a new customer choice that we are able to offer to our customers that gives them

the price stability that they're generally looking for when they're interested in rooftop solar.

And we'll get to some of those benefits as well. We propose this program as part of our 2015 rest implementation plan. We have a hard cap in this initial phase of the program of 600 homes and/or a \$10 million budget. Based on the numbers that we'll talk about a little bit later, we're certain we're going to hit the 600 home cap before we come close to the \$10 million budget. But as part of our 2016 implementation plan, we requested the opportunity to install an additional 1,000 homes with a corresponding budget, and we still haven't been authorized to do that yet. That sort of leads to one of the challenges right upfront with both our program and ATS' program is the getting regulatory approval, bringing it in front of the corporation commission, and there certainly are special interests that aren't very interested in Tucson Electric Power being able to partner with our customers and install rooftop solar.

So we're still hoping to get that approval for the expansion of the program. We really do see this as an offering – a new product offering from Tucson Electric Power to our customers that will continue as long as they're interested and we share their interest.

Slide 13:

So the value to the utility, we could talk about ray design all day, and I would really enjoy it, but I won't. And just to say that one thing we do see from our program is that now that we're maintaining that relationship with the customer and we're also maintaining that revenue stream. And so this program goes a long way to reducing the impact of cost shift from solar to non-solar customers from our perspective, and that's one value we see to it.

As I mentioned, the systems are connected to our side of the grid, and that gives us the opportunity to do a lot of interesting stuff with them, which I'll speak more to later. But then getting back to that retention of customers, really maintaining that relationship and building on it is really important to us.

Slide 14:

How we do that is every one of our program participants, once the system is installed and commissioned, get placed on a unique solar tariff that is no longer based on volume metric pricing. It's a fixed fee for up to 25 years, and it is based on the previous 12 months usage, and then there's only three ways that fixed energy rate can change.

One- or the two would be if they use more or less than 15 percent of the contracted usage in a given program year that we used to

base their fixed fee on. And so we see those as sort of guardrails to plug in their whole neighborhood, or if there are dramatic gains of energy efficiency or lifestyle changes that their fixed fee will be reset accordingly in the same way we set the initial time around. The third option, which we think is really a benefit to the homeowner and definitely differentiates our program from other choices they may have is what we refer to as the regulatory out. That means that as we are regulated by the corporation commission, if they are to determine a rate change that would affect our solar customers in the future and our solar customers are no longer interested because of that change – are no longer interested in being part of the program, they're able to exit the program.

We would remove the system, place them on the appropriate residential tariff at the time, and there'd be no fee to them. So we refer to that as the regulatory out. But aside from those three different scenarios, their energy price is fixed for up to 25 years. We've seen in our service territory that is one of the main driver of homeowners deciding to go solar is it's really fixed that energy attainment.

Slide 15:

So the value to the customer, I touched on it a little bit. That price security. We own and operate the systems. There's really no upfront cost to them. There's the \$200.00, \$250.00 processing fee that they pay when they're put on the new rate, but they're able to partner with a company that's been in the community for over 100 years, and then they have those additional consumer protections, one of which is the regulatory out. But as we're regulated by the Arizona Corporation Commission, they have an advocate there if they feel they need to bring an issue to their attention. So we see that the customers do get some value out of this, and they're very interested.

Slide 16:

This is just a brief example – or one example of what the build would look like for a homeowner that's participating in our program. They have that fixed solar rate that you see there for up to 25 years based on their previous 12 months usage, and then in this case, there's about \$12.00 of taxes added onto those. We don't have control over those. So those may adjust over time, but for the most part, their bill will be fixed. You can see how it compares to their previous average. It's worth noting that our program does not base and certainly not presented to the customer on saving money.

It's really about that price security and the usage flexibility. But generally, when we calculate the fixed rate and we add in the taxes,

we see their payment is going to be roughly equivalent to their previous average bill. And sometimes it's less, sometimes it's a little more, but generally it's right there.

Slide 17:

Now we're getting into some of the aspects of the program I wanted to highlight in terms of the existing utility business model having value when it comes to deploying residential solar. And one of those has to do with program marketing.

Now this slide actually has two purposes, so I'll get the first one out of the way. We didn't spend a dime on marketing for the most part. We issued a standard press release once the program was more or less approved with the condition, and as you can see, it generates on the bottom left there. We have articles in the local paper. We have segments on the local news channels. We did an article in our plug-in newsletter that we distribute to about 80,000 of our customers on a monthly basis, but we just did one article, and then we put it on the TEP website. And so there's that existing customer relationship, which we'll talk about a little bit later. In terms of marketing, we didn't have to do any, and that brings me to the second purpose of this slide, which is to say that was one of the challenges of our program is the fact that it is limited in nature.

We have those 600 spots that are available, and the limited announcements that we did do, they all pointed interested homeowners to our website where they could register their interest, and it was those customers that we then announced open application periods that were filled and first come first serve, and just to give you a little example, on our second application period back on September 8, we had over 300 clicks on the application link in the first 30 seconds, and we had to take it down. But it's a good challenge to have, but really managing the interests of the program, our list is over 5,000 now.

And managing the expectations and interest for the customers with the fact that we only have 600 spots. You can also see the industry talks about our programs and APS' program that happens as well. So in terms of marketing, definitely not a whole lot in terms of money we had to spend to get the word out about our program.

Slide 18:

Next slide. That dovetails nicely into the relationship with the customer that I've mentioned. We really did see this as an opportunity to engage with them and educate them both through our program collateral and energy efficiency offerings, and the customers that we're seeing, they're the 300 that clicked within the first 30 seconds.

So they are dialed in, they're generally very interested in what the utility is doing, they're obviously interested in renewable energy, and it's a great opportunity to really partner with them. And then I go out to these installs from time-to-time as they're completed and happened to bump into this lady on Tuesday, and we asked them – when we run into homeowners, we ask them how their experience has been. And verbatim, this is what she told me, so I thought I'd include it, and she told me I could use her last name. But we're still glad that we waited for a program like this with TEP, the company we trust and feel comfortable with.

Their method simple. So there really is that sentiment out there, and there are customers that have actually waited for an opportunity like this to participate in rooftop solar with their local energy providers. So we – that is the reason for our program.

Slide 19:

Again, more to do with the solar aspect of the program. We ran a procurement or an RFP through our procurement department, competitive bid for PV module converters. We had great response and the companies were very excited to partner with us specifically for this program.

And we ended up selecting REC modules, and then TwinPeak Series converters and where we came in well under a dollar a lot for bad material – the bulk of the system cost I think is safe to say there. And so though we ordered them directly from the manufacturer and they were shipped directly to Tucson Electric Power, which will take me to the next slide here.

Slide 20:

One of the aspects of implementing this program is that we house the modules and the inverters for the installations, and it was nothing for our materials management services to accept 3.5 megawatts of PV panels and hundreds of residential inverters. The inverters are right next to the module there. But they're used to this.

They've been doing this for years. They manage 40 acres of inventory here just in that shaded area that you see. They deal with over 20 different customers on a daily basis both internal and external that are doing material pickups. So for them, it was no big deal to have three solar installers showing up daily and picking up inventory to do these installations. I think APS does their program a little differently than ours, but we've seen great value here from our perspective in terms of managing at least the modules and the inverters.

Slide 21:

As I mentioned, the solar alliance contractors, as we call them, can come and pick up at their schedule on a per job basis or they can bundle jobs as they need to, come pick up the modules and the inverters from our campus there.

And they're able to – they have complete access to our internal workflow management system, and they schedule the pickups with our material management services. A lot of people throughout the company, this program has touched countless departments within the company, and everybody involved in this program has done an incredible amount of work. And it's really exciting to see this thing take off. I've got to tell you, the material management service was probably the most streamlined part of this whole implementation process. I had to rearrange some shipping dates because the installs would run a little slower than we expected them to at first, and I was concerned, and I thought, "Well you know, the modules aren't getting picked up as quick. Is that a problem?"

No, doesn't matter. We'll just stack them over here. So it really, really has been a really smooth part of the program implementation. And that leads to the last slide here.

Slide 22:

Second to last slide of detailing the relationship that we've developed with our PV installers. We, like APS, partner with existing solar installers to implement our program. We did a competitive bid and ended up selecting these three. I did my best to make sure their logos were all the same size, and I assure you they are in no particular ranking there. But they are responsible for the system design. They're sending that to customers' kitchen table, doing the contract, execution, explaining the program. They take it from there with a system permitting.

As I mentioned, they take up the material. We have them supply basically the balance of system, a size that's required for the installs. So that would be your racking, your sand offs, your flashing conduit wire. They manage their businesses like they have been for years. We supply the modules and inverters, and of course they care of the install, they schedule the inspections, and during the installation phase, they really are the main point of contact with the customer, and they're doing a great job of maintaining that and developing their own relationship with our customers, and so far, it's worked out really well.

And they do all this for us the way we structured it, with a fixed dollar per watt cost. And so no matter what the system size of a

particular job is, they will invoice us based on their fixed unit fee for however large the system was. And so far, that seems to be working out real well, and we think that it's provided a lot of certainty for both us in terms of our budget, but also for them in terms of cash flow and managing our businesses. So with that, I'll move to the last slide here, just a quick overview summary of the programs, the dates.

Slide 23:

As I mentioned, we got over 5,200 currently on our interest lists. Those are the people we communicate with relatively often when it comes to announcing our application periods. We try to accept about 200 applications at a time. We have 210 signed contracts now out of that 600, so we've got a little ways to go and we got 60 installations. So we definitely plan on seeing those two numbers ramp up here in the next couple months certainly.

All in cost, we're pretty excited about this number. Two twenty-five is what we see for residential solar. That includes the limited or non-existent customer acquisition cost. That includes design permitting, equipment, and support installation interconnection. We feel we think that's our all in number. That's what we're going to be basing our tax credit on. So that's why we are incredibly confident we'll come well below that \$10 million budget for 600 homes.

Slide 24:

And I think I saved some for Marc to talk about, and I was told to make sure I end on something topical and relevant. So I'm happy to answer any questions and thank you for your time.

[Speaker: Kristen Ardani]

Okay. Let's go ahead and take a couple questions before moving into Marc's presentation. I think from what I'm seeing coming in from the audience, there seems to be a little bit of confusion sort of around the amount that's paid. So for example, there's a question here that could you please just clarify is the 1,650 per kilowatt page the customer buy the utility, or is that from the utility to the customer?

[Speaker: Justin Orkney]

Yes, so I didn't spend a whole lot of time discussing the specifics of the rate, but that 1,650 is a value that we – it's a multiplier we use to calculate their fixed payments. So we're not paying the homeowner anything in this program. They're partnering with us. We're installing the system on their roof. We are charging them a \$200.00 processing fee when the installation is complete, and then we're putting them on that fixed payment. How we calculate that

specifically is we take a look at their previous 12 months usage and we calculate what we refer to as a solar rate capacity. We basically divide that annual usage by what we see in a production level of the amount of kilowatt hours we would expect to see from a kilowatt of solar, and we use 1,900 kilowatt hours a year.

And we take that solar rate capacity and then we multiply that number by 1,650. And that is how we come up with the fixed payments the homeowner then has. Hope that answers the question.

[Speaker: Kristen Ardani]

I think that was a great job of answering the question. So does that mean that TEP thereby eliminates all dollars per kilowatt hour charges altogether now that it's on a 1,650 per watt fixed rate?

[Speaker: Justin Orkney]

Yes, and that was if you want to tap back, you can, but one of the values that we saw as a utility was this was a step forward – step away from the traditional volumetric pricing that obviously there's a lot of conversation about right now. And so yes, the homeowner now is on a fixed payment, and as long as they use on a given program a year between plus or minus 15 percent of that annual usage that we base their fixed payment on, their payment won't change. And so if they use 10,000 kilowatt hours one year, they'll have a certain – you can do the math, and they would end up having a certain dollar per kilowatt hour charge if you will.

But they could use 11,000 the next year, and if you did the math, they would have a lower dollar per kilowatt hour. So their payment doesn't change as long as their usage on an annual basis stays within plus or minus 15 percent in terms of kilowatt hours.

[Speaker: Kristen Ardani]

Thank you for clarifying that. Let's see here, maybe we have time for one more quick question before moving into Marc's, and then we can take the remainder of these questions at the end, hopefully, time permitting. So has TEP considered any kind of batteries to be paired with the utility under top PV? Any kind of storage solutions being considered today or possibly in the future?

[Speaker: Justin Orkney]

Yeah, great question, and thanks for asking it. So broadly speaking, we see this program as a little bit more internally than just an opportunity to install residential solar. We really see it as sort of developing a platform within our company that we will be

able to explore these other and new distributed energy resources that are coming down the line such as distributed storage, demand response, what have you. We've developed a program now and we've seen what it takes and we can change it if necessary. So we certainly are paying attention to those developments. When I first started developing this program, the idea was maybe there would be some storage, and that was two years ago.

And residential storage really had no value to the utility, and it was expensive, and certainly it's come a long way even in the last two years. So we will definitely be paying attention to that space and will be looking for opportunities to partner with our customers in a way that makes sense both for the company and for them. So absolutely.

[Speaker: Kristen Ardani]

Great. And thank you everyone for your excellent questions. Let's go ahead and move to Marc's presentation at this time, and then we'll have more time for Q&A at the very end. So with that, I'd like to hand it over to Marc.

[Speaker: Marc Romito]

Slide 25: Great. Good morning to those of you on the west coast, and good afternoon to everybody else. Happy Friday to anybody in Asia. NREL, thanks a lot for hosting this, thanks for putting it together. We certainly appreciate your participation in what we're doing on the technical side and many conversations we have to look forward with you.

Slide 26: So let me jump in here and preface what I'm going to talk about today first off. What we're doing in the rooftop solar space at APS is technical in nature. I can certainly get into some of the customer offering programmatic details. However, as a baseline, what we're doing is technical R&D for specific reasons that fit in our strategic vision for distributed energy resources. We are not new to doing R&D in the rooftop space. We have done utility owned rooftop pilot projects before.

Namely one, a substance in flagstaff, where we were examining the impacts of high penetration PV on one specific feeder at the time as many of you may remember. There were rules of thumb for what high penetration meant back in those days. There were not established distribution modeling tools to look at intermittency in real time, so we cracked – helped crack some of that code in flagstaff. In this specific ownership round, we're looking at something else. So that's a preface.

We may also say that there are a handful of utilities around the country, quite a few actually, and more coming into this category as we speak, but APS as well as Tucson Electric and obviously the acronym I use in California, certainly Hawaii and other utilities in Texas and New England, are what we call high penetration solar utilities. That means we have a whole lot of solar on our system. In Arizona, we see a whole lot of distributed solar on our system. We're a 1.2 million customer utility. That's a medium sized utility compared to the rest of the pool of IOUs. We have a large service territory. I believe it's sixth largest in the country.

We see between 80 and 100 megawatts per year now of residential PV coming onto our system. Our total pool of distributed generation is about 500 megawatts and 1.2 gigawatts of renewable energy. Our system summer peak is 7.3 and some change gigawatts, and our shoulder off season peak is around 2,300, 2.3 gigawatts. So high penetration really has a seasonal issue. We obviously see it more in the shoulder seasons, but there's a lot of solar on the system. And there's a lot more coming. We see record applications year over year for our service territory and per capita, and we're looking at 1,300, 1,400 applications for rooftop residential solar a month, and that trend should continue or not increase, and we see that happening for the foreseeable future in the long-term. It also won't be held to just PV. We recognize customer technologies are changing.

The use of PV, the use of storage, the use of other types of distributed devices is something we need to be able to stay ahead of, to embrace, and to work with. So right now, going back to what we're doing with this specific round of project work is we're looking to increase our ability to be an enabler of those type of technologies. We have significant grid impacts from the distributed generation. We see voltage irregularities. Pretty substantial voltage excursions on various feeders throughout our system. We right now are experiencing reverse power flow onto the EHB from some of these feeders.

That obviously represents a challenge. It's a technical challenge. It's a power quality issue, and it's something that's important for us to be able to manage and mitigate, and we also see a difficulty in our ability to efficiently plan our distribution system investment. The infrastructure itself needs to evolve and modernize in order to accommodate bidirectional flow. And that may sound like a – I don't know, it may sound to some people like it's kind of boring, but to us it's about as exciting as it gets. That's a different world of

distribution planning, distribution engineering, and the distribution paradigm than it used to be.

In the old days, you'd see a distribution engineer here. She would build to load and call it good, and in these days, it's not how things are done. Parts of our system are very different than other parts when it comes to PV penetration. The driver for a lot of the explosive growth has of course been the leasing, financing model. That tends to cluster. Random to cluster where the PV is going by demographics. Long story short, you're looking at people either who can afford the technology or have the credit score capable of doing it. It obviously doesn't apply to everywhere in a service territory equilaterally. So it makes the planning environment difficult.

Obviously as a vertical utility, we are a balancing authority as well. We are not in the ISO RTO model. We're vertical just the same as Tucson Electric. They're also a balancing authority. The distributed generation, the size of – the amount of DG that goes on in the system obviously impacts regional planning in the minute-to-minute market of wholesale transactions. So we don't just see impact on the distribution system. We see impact at the **weck** level. We're also seeing issues that are being dealt with in terms of customer impact. Cost shift is something that has been discussed widely in Arizona, and currently in many other states from the subsidy model and energy metering. That's an important conversation to have.

We also see because of the clustered effect of high penetration a declining ability for customers to add other behind the meter technologies because of the grid impacts.

Slide 27: Here's a nerdy chart. So anybody wants to see what types of application rates and trends we're looking at. We can go to the next slide.

Slide 28: That's something just to chew on and dissect later. So what are we doing about it and what's the point and what are we doing to help mitigate some of these adverse impacts and to enable technologies? R&D is where we're sitting.

I mentioned these programs that we're doing, these pilot projects, are important for us to handle these technologies and stay ahead of the curve. We don't want to get caught behind the curve on these technologies. These are complex and technical issues, so when I get into some of the nuts, I'll try to stay high level, but this isn't just

a programmatic thing for us. This is something we're doing to mitigate power quality issues and to really move the grid forward and to modernize it, and that's not just – that has a lot of overlap with a lot of different technical components of the business I'll get into in just a little bit.

We have obviously seen a shift in Arizona from a compliance driven market to one that does not need subsidy from the purchase of renewable energy credits. In Arizona, that was one of the legs that prompted distributed generation's growth, and we have seen absorbent amount of growth of rooftop solar without the compliance backing. So we see this happening into the long-term, especially with the extension of the investment tax credit, the leasing financing model. This is something we're going to be having technical conversations about for years and years to come. We want to make sure what we do in the future is built on understanding, objective understanding of these technologies, how they work, how they interoperate, how they interoperate with our grid.

So we need to be doing some specific R&D now, and our long-term vision is a sustainable outcome. We want something that will work for customers at the end of the day. That's what we're doing. So I'll now move in, you can go to the next slide, to talk about two of the specific pilot programs we're working on now.

Slide 29:

But first, let me say that this is our vision, this slide here. We see a desired in state that the grid is the enabler of technologies. And at APS, that isn't a game. That's exactly what we're doing. With the current rooftop ownership program that we're working on, it's centered around advanced inverters, and that's the core of that project. We need to build the communications infrastructure. That would allow us to communicate and control those advanced inverters. We need to have understandings around that communications.

And that point of security and resiliency cannot be understated at all. We don't play a game in the electric utility industry. We're a part of upholding the critical backbone of the Arizona, of the American economic infrastructure. This isn't an opportunity to screw up. We have 24/7, 365 reliability requirements, and we take that incredibly seriously. There's a degree of reverence for operations control around here that warrant taking this type of what I'd say smart grid device control communications algorithm very seriously. So cyber security is at the forefront. So whatever

happens in the DER space, that needs to be top of mind. You don't have to look too far.

Recently, stories from the Ukraine, issues with different federally or nationally sanctioned organizations trying to bring down infrastructure all over the world. So this is something that's on the tip of our mind. We think in terms of safety, reliability, and affordability, we also need to extend that reliability into resiliency. So developing a communications infrastructure with aggregated DERs out on the distribution system has to be done with cyber security at the forefront.

For the advanced inverters, we're looking at power quality contribution potential. We see voltage irregularations, phase imbalance, frequency issues. What is the capability of the advanced inverter technology to be able to not only mitigate some of those issues, but offer potential benefits as we get into a more sophisticated distribution planning environment. That's a conversation that's happening here, it's a conversation that's happening in Hawaii, and certainly in California. And possibly in other states, I don't want to leave anybody out.

And then in the west, we see sub-type penetration that there are reliability driven potential events depending on seasonality where you may need to curtail certain resources at certain times of the day. So that capability is also built into the advanced converters. The other thing that we're doing on the second pilot project I'll get into in a little bit of detail is align the customer technologies with our system needs via rate restructuring. Now that sounds like a bundle in a phrase on the Power Point slide, but we need to make sure there's a win for customers at the end of the day.

That customers are able to embrace the types of technology they'd like to use, that they're able to save money on their bill if they can, if those types of technologies are available to all types of customer classes, or the benefits derived from them can be extended to more than just the wealthy. And those customers are going to be looking at things like PV and storage and other technologies we won't necessarily talk about. So we need to create an environment that's sustainable, that's a win for customers, that allows the third party marketplace that's going to be building, installing, and maintaining distributed resources in the long-term.

We need to make sure that environment is healthy, and we also need to make sure these customer technologies align with the system, that they work, that they plug in well, that they're safe, and

that they align with what we call our system load profile. We don't need a whole bunch of daytime generation in the western United States. It's actually destructive. So we're looking at tying those rate structure into the technology environment and then taking that communications path into what we consider our automated distribution management environment.

All utilities are different. Some don't have AMI, some do, some don't have distribution management system, no skate at the distribution level. Here we do, and part of our strategy is to tie the communications of those technologies into the what we call the ADMS, and think of that operating just like you would all other smart grid devices into one central control, aggregated central control and decision-making for effective managing of the modernized grid.

Slide 30: So the two programs we can talk about is the solar partner program and the solar innovation study. The solar partner program has received quite a bit of attention, and we can go ahead and move to the next slide around the nation.

Slide 31: We're installing about 1,500 solar systems on residential properties. These systems are all west to southwest, facing with the exception of a small handful on a specific use case we're looking at of high penetration. Every one of them is employed with advanced inverters. Two specific manufacturers that have just recently – the first two completed actually recently come through the UL certification process. One is complete.

One of those inverters, manufacturers on our project was what we call awakened or went live in the field last week. That was a major milestone accomplishment for distributed generation in the US, completely integrated, centrally controlled, UL listed deployment of advanced inverters. And this is where we're seeing the two-way communication with each one of these sites. We've got some specific use cases. As I said, this is technical in nature. I can get into a little bit more detail in a minute. We're also looking in this pilot project at another use case of the coordination of utility cited battery storage on a couple specific feeders. We're looking at two, two megawatt hour battery installations working on conjunction with the advanced inverter control system in the PV performance.

This will be collected and analyzed in real time. Keep in mind what we're doing is fully automated, so we can signal to the advanced inverters during the certain seasons on specific feeders when and how we need to, and then measure the impact on real

production from the system how these inverters are working and look to the future of the type of requirement we're going to need for advanced inverters in the interconnection sphere in our service territory. And go into the next slide.

Slide 32:

This program is pretty simple for the customer. It's not a programmatic approach to utility ownership over the long-term in the sense of a customer offering. Like I said, this is R&D, so what we're doing in this case is effectively leasing customers' roof. We give them a \$360.00 per year bill credit for their participation. The PV is obviously connected to the utility side of the meter, so we can control it, test it, mess with it, and understand what it's capable of doing. On some of the specific use cases, we're looking at the proof the advanced inverter to actually effectively make contributions in the power quality arena. Voltage regulation is one of the critical components of that. Another thing we're doing – there's been a lot of talk, a lot of narrative around capital deferment from high penetration PV deployment.

And there needs to be some objectivity inserted into that dialogue, so one of the things we're looking at is so you have a high daytimed load constrained feeder. You want to put a certain amount of PV on that feeder. The logic would suggest that you can alleviate a heat constraint by putting localized generation on that feeder. So you know, what we've learned in Arizona is sometimes with intermittent generation, what you actually end up doing is go from hot/cold, hot/cold, hot/cold, and you actually can break things more than you can benefit things.

So we're looking at that use case, we're considering how do you look at ancillary services in conjunction with the batteries. So we see the power quality contributions. We know the intermittency impacts. What if you couple that with the storage, and then taking a step back from that, what's the economic reality of having done all that in the first place up against reconductering line extensions, some other more conventional distribution planning or distribution engineering approach? We're looking to validate some of the models we've done with conjunction with NREL and DOE on modeling intermittent impact on specific feeders, and then what captures the entire program here is communications infrastructure.

Besides a handful of specific feeders with very specific use cases, being able to build the communications infrastructure cyber secure environment into our metro area in Phoenix out into the state service territory because we do cover the bulk of Arizona, we need

to make sure that capability is attained. We can go to the next slide.

Slide 33:

Okay, the next study that we're doing, and I'll go through this one pretty quickly, is very exciting project. We know that PV isn't the end of the game, or we're looking at combinations of customer technologies, and so we've propped up a study called the solar innovation study.

This is where we're taking 75 homes and looking at the interoperability of solar advanced inverter battery storage load management, load controllers, energy management systems, multi-stage air conditioning, smart thermostats, looking at the interoperability of all those technologies connected behind the customer on the customer side of the meter, and they knew rate paradigm. So we've had demand based rates around here for a long time since the '80s. Ten percent of our residential customer base is already on demand rates, and we see a bright future, a non-contentious sustainable future for customer cited DER working in harmony with a better price signal that allows the customer to take control of energy use, save money that aligns with the system.

Requirements obviously – the curve has been a big conversation out west, and then provides an opportunity for third party installers and integrators of those DERs to thrive without any contention whatsoever. AKA, the net metering controversy disappears and we see a sustainable future. You can go to the next slide.

Slide 34:

Okay, this is a view of what we call the ecosystem. It's not as easy as it sounds. People like to talk about some of the white paper work that goes into interoperability. Getting all of these customer cited DERs to talk together just within the home envelope is complex, and a great example is the HVAC industry doesn't necessarily want to align technically with the thermostat industry.

Think Smart thermostats, Think Smart HVAC, nobody is really talking about multi-stage and variable speed air conditioning, but getting all those communication protocols developed is a pretty substantial challenge. Allowing that then to talk in an encrypted and secure way to the operations environment of the distribution grid is taking the solar partner program and ramping it up several technical notches to see that technical alignment work in conjunction with our system harmony, and then allowing the customer – this is all about the customer.

So the customer has then an app built in to be able to control, override, observe depending on the customer's desire what's going on his or her home. That's a relatively small pilot project, but it's obviously very important because it's the future as we see it for how DERs will work, how they'll aggregate into our distribution planning environment, and how they will provide a sustainable future for third parties in – and that's obviously, go to the next slide, that's a win for everybody.

Slide 35:

So we don't take that as fiction. We put that as a part of our vision, and we're very excited about that pilot. It also helps us to keep our finger on the pulse of the state of the best technologies and their capability of interoperation in the customer envelope. So we will be able to, again, be that enabler of technologies, serve customers safely, reliably, affordably in a resilient environment. We see this as something we have to do, not something that is an option. We're excited to stay ahead of the curve. We think we're breaking some new ground in some of these initiatives, and we would recommend to anyone who is on the phone who is thinking about this from your own sphere if you're in the utility world; every utility distribution system is a bit of a snowflake. So this isn't something that APS can just do and then the problem is solved.

Its feeders are all different, distribution systems are all different. Customer behavior is different, and preferences, geography. So this is something that could ideally be replicated elsewhere. We're of course sharing our advanced inverter work with NREL, with – EPRI is running the analytics for us with other utilities participating in the advisory council, and with the third party industry who has been present in leadership in this program.

Slide 36:

So I think that's moving onto the last slide, that's it. You know, we can talk a lot about this. There's obviously a whole lot embedded into it on the technical side in the strategy side, but the bottom line – keep in mind, going back to one of my early slides, becoming an enabler is our vision, and we see there is a technical path to get there over the period of a few years, and it requires us to be current, keeping in mind a rooftop PV is just a subset of the technical footprint of evolving DERs, and the coming together of DG and renewable energy portfolios with sustainability, energy efficiency, and demand side management portfolios.

So we're attempting to do our best to solve some of these grid issues and move this dialogue forward towards the future.

Slide 37:

That's all I have. Happy to take questions and have a conversation.

[Speaker: Kristen Ardani]

Slide 38: Great, okay. Thank you both, Justin and Marc, for your very informative presentations today, and thank you everyone for joining us. Again, in front of you, you have the link to the DGIC web page, the presentation, recording, and slides will be posted here following the webinar, and also a FAQ of questions that were not answered during today's presentation. And again, our application for utility technical assistance closes this Friday, January 22nd, so please do get your applications in, and you can find the application here at the technical assistance page listed below. Thank you everyone.

[Speaker: Justin Orkney]

Thank you.

[Speaker: Marc Romito]

Thanks a lot.

[End of Audio]